Appl. No. 10/085,061
Amdt. dated January 20, 2006
Reply to Office action of September 20, 2005
Atty. Docket No. AP1107US

Amendments to the Specification:

Please replace paragraph [0003] with the following amended paragraph:

[0003] -- DSL or Digital Subscriber Line is a system wherein a non-loaded local loop provides a copper connection between a network service provider and customer premises. DMT is a common form of modulation used in DSL systems. In a DMT based DSL system, the required ~~peak-to average ration~~ peak-to-average ratio (PAR) of a signal is 15 dB for the probability of a clipping occurring to be 10^{-8} (assuming a Gaussian distribution) --

Please replace paragraph [0008] with the following amended paragraph:

[0008] -- [[The]] Embodiments of the invention ~~provides~~ provide a signature waveform which introduces no or minimum signal distortion. The signature waveform is designed so that whenever the signal is above a maximum level, the signature waveform is subtracted from the signal peak position. As a result, the signal will not be saturated. The advantages of such a signature waveform design are that the PAR can be reduced by as much as 6 dB, and no distortion is introduced into the transmission signal. The transmission signal has no distortion after peak deduction. --

Please replace paragraph [0009] with the following amended paragraph:

[0009] -- Accordingly the present invention provides a method of effecting peak reduction in a DMT signal, comprising the steps ~~of creating a predetermined signature waveform, and subtracting said predetermined signature waveform from said DMT signal in the region of a signal peak whenever the DMT signal is above a predetermined maximum level.~~ (i) providing a predetermined signature waveform (s(n)), (ii) for each frame of samples of the DMT signal, identifying a maximal value of amplitude (M) and the location (I) of said maximal value within said frame, (iii) comparing the maximal value with a threshold value and, if the maximal value is not less than the threshold value, (iv) multiplying the predetermined signature waveform by a scaling factor (C) to obtain a scaled signature waveform, and (v) subtracting said scaled signature waveform from said DMT signal frame so as to reduce said peak to a level substantially equal to said predetermined threshold value. --

Please replace paragraph [0010] with the following amended paragraph:

[0010] -- In a preferred embodiment the signature waveform is generated by an iterative process [[from]] whereby a predetermined starting waveform ~~and passing it~~ is passed repeatedly through time

domain and frequency domain restriction units. --

Please replace paragraph [0011] with the following amended paragraph:

[0011] -- Typically the signature waveform is aligned with the time domain DMT output signal and multiplied by a scaling factor derived from the maximal value of the time domain DMT output signal. The result is passed through a bit shifter to match the number of bits per sample of the result with the number of bits in the samples of the time domain DMT signal. --

Please replace paragraph [0012] with the following amended paragraph:

[0012] -- The invention also provides an arrangement for effecting peak reduction in a DMT signal, comprising ~~a first circuit for creating a predetermined signature waveform, and a second circuit for subtracting said predetermined signature waveform from said DMT signal in the region of a signal peak whenever the DMT signal is above a predetermined maximum level.~~ (i) means for providing a predetermined signature waveform (s(n)), (ii) means for identifying, for each frame of samples of the DMT signal, a maximal value of amplitude (M) and the location (I) of said maximal value within said frame, (iii) means for comparing the maximal value with a threshold value and, if the maximal value is not less than the threshold value, (iv) means for multiplying the predetermined signature waveform by a scaling factor (C) to obtain a scaled signature waveform, and (v) means for subtracting said scaled signature waveform from said DMT signal frame so as to reduce said peak to a level substantially equal to said predetermined threshold value.

Please replace paragraph [0013] with the following amended paragraph:

[0013] -- [[The]] An embodiment of the invention will now be described in more detail, by way of example only, with reference to the accompanying drawings, in which:
FIG. 1 shows one embodiment of a circuit for reducing the PAR of a signal; and
FIG. 2 is a block diagram illustrating the calculation of a signature waveform. --

Please replace paragraph [0015] with the following amended paragraph:

[0015] -- The invention uses a few bits and a short vector for the signature waveform so that both the memory and computation requirements are minimized. Also, by carefully choosing the value of a scaling factor C, as defined below, it is possible to achieve the maximum PAR reduction by 6 dB and maintain minimum signal distortion. The signature waveform [[s(k)]] s(n) is represented by a 256 byte vector (256.times.8 bits) with a maximal value of 0x 7f (0x indicates hexadecimal notation,

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so, for example, 7f would be 01111111 in binary notation). --

Please replace paragraph [0016] with the following amended paragraph:

[0016] -- Referring now to FIG. 1, a practical implementation of the invention comprises an IFFT (Inverse [[~~FAST~~]] Fast Fourier Transform) unit 100 which receives a frequency modulated DMT input signal X and outputs an IFFT time domain signal [[~~$x(k_1)$~~]] $x(n_1)$, which is represented as 16 bit numbers. The output signal [[~~$x(k_1)$~~]] $x(n_1)$ is fed to a subtractor 101. --

Please replace paragraph [0017] with the following amended paragraph:

[0017] -- In the meantime, the IFFT 100 unit calculates the maximal value of the amplitude (M) in a DMT frame together with the address I of its location in the series of bits in the frame, and supplies them to a threshold calculation unit 102, which compares the absolute maximal value |M| with a threshold 0x08000 and outputs a scaling factor C which is used to scale a signature waveform s(n). If the absolute maximal value (|M|) of the time domain signal [[~~$(x(k_1))$~~]] $(x(n_1))$ is smaller than threshold 0x08000, no action is required for PAR reduction, and ~~the comparison output C is set~~ the threshold calculator 102 sets scaling factor C to zero. Hence, following multiplication, the signature waveform also will be zero. Otherwise, if the maximal value (|M|) is equal to or greater than threshold 0x08000, the threshold calculator 102 outputs ~~the address location of the maximal value (I) in the series of samples and carries out the following steps~~ a scaling factor C having a value derived as follows: --

Please replace paragraph [0019] with the following amended paragraph:

[0019] -- While the signature waveform is to be subtracted from the signal [[~~$(x(k_1))$~~]] $(x(n_1))$, it must first be aligned with the signal peak bearing in mind that the signature waveform is only 256 bytes long. It must also be remembered that the signature waveform consists of only 8 bit samples whereas the signal consists of 16 bit samples. --

Please replace paragraph [0020] with the following amended paragraph:

[0020] -- Alignment of the signature waveform with the peak is achieved by taking IFFT output samples at addresses [[k_1]] n_1 ranging from [I-128: I+127] (before the prefix, suffix and window are added), and subtracting the signature waveform multiplied by ~~a suitable~~ the scaling factor C where C is determined as follows:

$$|M| - ((C \times (0x0080)) >> 7) = 0x08000$$

$C = (|M| - 0x08000) \times sgn(M)$

Please replace paragraph [0021] with the following amended paragraph:

[0021] -- The address [[k_1]] $\underline{n_1}$ for IFFT output x should be cyclically extended, i.e., if [[~~$k_1<0$~~]] $\underline{n_1 \leq 0}$, the true address should be [[~~k_1+N~~]] $\underline{n_1+N}$, where N is the number of FFT points (For a normal DMT based DSL system, N=512, 1024, 2048, 4096 and 8192), and if[[~~$k1>N-1$~~]] $\underline{n_1 \geq N-1}$, the true address should be [[k1-N]] $\underline{n_1-N}$. --

Please replace paragraph [0022] with the following amended paragraph:

[0022] -- The signature waveform [[~~s(k)~~]] $\underline{s(n)}$, which consists of 8 [[bits]] bit samples, is then multiplied by the scaling factor C, which consists of 16 [[bits]] bit samples, in multiplier 103. The result is a 23 bit number which is shifted 7 bits to the right in unit 104 to give a 16 bit number that is subtracted from [[~~$x(k_1)$ in~~]] $\underline{x(n_1)}$ by subtractor 101. --

Please replace paragraph [0023] with the following amended paragraph:

[0023] -- ~~The creation of the signature waveform is performed as shown in FIG. 2.~~ The signature waveform calculation is [[shown]] illustrated in FIG. 2. First an initial frequency domain waveform $\underline{S_1'(k)}$ is selected and ~~the frequency domain signal~~ passed through [[and]] an IFFT unit 201 to produce a time domain signature waveform s(n). This ~~signal~~ waveform is then ~~checked~~ compared with a ~~required threshold~~ a waveform restriction profile in unit 202 and any time domain samples which are ~~above threshold~~ outside the profile are ~~corrected to produce~~ limited to the profile value, producing a modified time domain signal $s_1(n)$. This signal $\underline{s_1(n)}$ is passed through FFT unit 203 to produce a frequency domain waveform S(k). --

Please replace paragraph [0024] with the following amended paragraph:

[0024] -- This signal S(k) is then checked against a required frequency mask in unit 204 and any signals that are [[above]] outside the mask are corrected to comply with the mask requirements. The output [[of]] $S_1(k)$ of unit 204 is passed back into the IFFT 201 and the process repeated on an iterative basis [[unit]] until either the waveform change becomes insignificant between successive iterations or a maximum number of iterations is reached. --

Please replace paragraph [0027] with the following amended paragraph:

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[0027] An example of frequency domain mask for unit 204 is:

$$\cancel{S_1(k) =} \begin{cases} S(k), & k \text{ is the region } 1 \text{ or small than required threshold} \\ \cancel{\gamma 1 \text{ x } sgn(S_1(k)),} & \cancel{k \text{ is in region } 2 \text{ and } |S_1(k)|>\gamma 1} \\ \gamma 2(k) \text{ x } sgn(S_1(k)), & k \text{ is in region } 3 \text{ and } |S_1(k)|>\gamma 2 \end{cases}$$

$$S_1(k) = \begin{cases} S(k), & k \text{ is the region } 1 \text{ or within the required frequency mask} \\ \gamma 1 \text{ x } sgn(S_1(k)), & k \text{ is in region } 2 \text{ and } |S_1(k)|>\gamma 1 \\ \gamma 2(k) \text{ x } sgn(S_1(k)), & k \text{ is in region } 3 \text{ and } |S_1(k)|>\gamma 2 \end{cases}$$